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ABSTRACT

A data base representing a random sample of more than 10,000 grade 9 students in an SISS (Second IEA Science Study) Extended Study (SES), a key project supported by the China State Commission of Education in the late 1980s, was employed in this study to investigate gender equity in student science achievement in China. This empirical data analysis uncovered significant gender differences across the nation. As a result of traditional Chinese culture, there is weak commitment to girls' education. Significant gender differences in science achievement were found in each of the five provinces studied (Gansu, Guangxi, Hubei, Inner Mongolia, and Jiangshu), however, two-way ANOVA revealed no significant interaction effects between province and gender on student achievement. The results are interpreted in terms of the educational, political, social, and cultural context in China. Contains 17 references. (LZ)

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An Empirical Study about China: Gender Equity in Science Education*

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An Empirical Study about China: Gender Equity in Science Education

Abstract

A Chinese data base representing a random sample of more than ten thousand 9th grade students in a SISS Extended Study (SES), a key project supported by the China State Commission of Education in the late 1980s, was employed in this study to investigate gender equity in student science achievement. This empirical data analysis uncovered significant gender differences across the nation. The result interpretation was made in terms of the educational, political, social and cultural context in China.

An Empirical Study about China: Gender Equity in Science Education

Since the late 1970s, a single-child policy has been implemented by the Chinese government to control the largest population in the world. Selective abortion to choose a male child could inevitably skew the Chinese gender distribution, and is clearly prohibited by the government. As a result, although boys are valued higher than girls in traditional Chinese culture, many parents eventually have a girl as their single child. Assessment of gender equity in education, especially in traditionally male dominated areas such as science and mathematics, is an interesting topic to most Chinese families. In addition, investigation of Chinese gender equity has attracted attention of many western scholars in international studies (e.g., Lapointe, Askew & Mead, 1992; Lummis & Stevenson, 1990; Postlethwaite & Wiley, 1992). Lummis and Stevenson (1990) maintained that "cross-cultural research is necessary to assess the generality of gender differences in academic performance and for gaining insight into variables that might be related to such differences." (p. 254)

In a summary of research activities in international studies, Torney-Purta (1990) concluded that the major comparative studies in education were carried out by the International Assessment of Educational Progress (IAEP), the International Association for the Evaluation of Educational Achievement (IEA), and a group of professors at the University of Michigan and the University of Chicago. To date, among those most recent studies reported to the public are: the second International Assessment of Educational Progress (IAEP) completed in 1991 (Lapointe, Askew & Mead, 1992); the Second IEA Science Study (SISS) conducted in the mid 1980s (Keeves, 1992; Postlethwaite & Wiley, 1992; Rosier & Keeves, 1991); and a set of publications developed by Harold W. Stevenson and his colleagues at the

University of Michigan and other institutions (Stevenson & Stigler, 1992). All aforementioned studies identified significant gender differences in Chinese students' mathematics or science achievement (Lapointe, Askew & Mead, 1992; Postlethwaite & Wiley, 1992; Stevenson, 1992).

Torney-Purta (1990) pointed out: "Although newspaper headlines have reported the major findings of these international studies, the details of methodology of the actual research have not been published in sources widely read by the educational research community" (p.32). Many scientists, sinologists, and educators believe that substantial methodology issues could affect results of empirical studies (e.g., Baker, 1993; Hoffmann, 1989; Rotberg, 1990 & 1991; Zimmer, Okamoto & Ho, 1994). According to Lapointe, Askew and Mead (1992), the authors of an IAEP report, a total of twenty Chinese provinces and cities were involved in the IAEP survey. However, the student sample size was insufficient, and no student enrollment lists were developed to ensure quality of randomization in the student selection. The SISS project and the other comparative studies conducted by Stevenson and his colleagues, on the other hand, were confined in a few major cities in China (Keeves, 1992; Postlethwaite & Wiley, 1992; Rosier & Keeves, 1991; Stevenson & Stigler, 1992). Cleverley (1991) pointed out:

> Given that some 80% of China's 1.1 billion population lives outside the major cities, crucial issues in the provision of national education lie there. It follows that the situation of rural education requires thoughtful analysis and public discussion. (p.53)

Thus, results from a few major cities may not necessarily represent the general situation of China. The researchers' purpose in this study is to investigate gender equity in science education based on both rural and urban information from a random sample of more than ten

thousand students in China.

Data Selection

Shortly after the Second IEA Science Study (SISS), the China IEA Center conducted a SISS Extended Study (SES) at the ninth grade level in science education. SES is the only nation-wide project in which a systematic population investigation was conducted and a comprehensive list of school enrollments was produced for a systematic sample design. As a key project funded by the China State Commission of Education in the late 1980s, the SES survey covered a random sample of more than ten thousand students from urban, suburban, and rural areas in China.

Unlike the SISS Pilot Study, the SES survey was not a part of the IEA SISS project. Nor has the SES data base been used by any international research organizations. Thus, the SES survey results can be employed as an independent source of information to confirm or disconfirm the result of gender equity assessment reported in previous studies.

It should be noted that IEA has launched a Third International Mathematics and Science Studies (TIMSS) project in the mid 1990s. No empirical data have yet been released from this on-going project. Hence, the SES data employed in this research are the most recent and representative data available to the public. Results of the data analysis may uncover more empirical findings for repeated confirmations in examinations based on TIMSS data and other studies in future.

Research Questions

Student science achievement was measured by an IEA SISS instrument. Development

of the instrument was a collaborative effort of international educators, including those from China and the United States (Rosier & Keeves, 1991). Questions that guide this research are:

1. Are there significant differences in science achievement between the Chinese male and female students?
2. Are there gender equity differences among provinces in Chinese science education?
3. What do the results mean in terms of the educational, political, social and cultural context in China?

Methods

In 1987, after the SES project was announced by the China State Commission of Education, seven provinces from five regions, West (Gansu and Sichuan), South (Guangxi*), Central (Hubei), North (InnerMongolia*), and East (Jiangshu and Liaoning), expressed interest in participating, and the China IEA Center included all of these provinces in this study. Hence, the survey was conducted over a random sample of approximately fifteen thousand (15,000) 9th grade students in the seven provinces. Consequently, some regions had more than one province participating in this project, and a direct integration of the seven provinces may cause an unbalanced regional representation in the national data base.

To balance the regional representation, only one province from each region was be included in the national data base. Accordingly, in this study, the student data from five provinces, Gansu, Guangxi, Hubei, InnerMongolia, and Jiangshu, were employed to represent the five regions in China. The integrated national sample over these five provinces contains

* The InnerMongolia and Guangxi autonomous regions are equivalent administration units of provinces.

approximately 11,000 ninth grade students (Table 1).

Based on the appended national data, the independent sample t test was employed to examine a potentially significant gender difference in science achievement at α=.05 level. Provincial differences in gender equity reflect the varying effect of gender among the five provinces. This variation also indicates the feasibility of examining gender equity across the nation without mentioning specific provinces. Statistically, a national comparison is feasible only if the interaction effect between gender and province is insignificant. The effect of interaction was tested in this study through a two-way Analysis of Variance (ANOVA), and the result was reconfirmed by t tests of gender equity in each province. Discussions of gender equity are based on the educational, political, social and cultural context of China.

Results

After deletion of missing values, the achieved sample sizes for this study are listed in Table 1.

Table 1 inserted around here

Results of t test based on the appended national data are summarized in Table 2.

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The two-way ANOVA about the effect of interaction between gender and province is tabulated in Table 3.

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The result of t test for each province is assembled in Table 4.

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Discussion

Significant gender differences in science achievement were found in each of the five provinces (see Table 4). The two way ANOVA also revealed no significant interaction effects between province and gender on student achievement (see Table 3). These findings indicate that gender differences are significant across China regardless the location of each province. Accordingly, in spite of the controversial sample designs employed in previous studies, these conclusions have been fairly consistent, i.e., girls in China do not achieve as well as boys in traditionally male dominated areas, such as science and mathematics (Lapointe, Askew & Mead, 1992; Lummis & Stevenson, 1990; Postlethwaite & Wiley, 1992). In the study reported herein, the t test conducted on the appended national data further reconfirmed the significant gender difference in Chinese students' science achievement (Table 2).

Hooper (1991) pointed out: "Throughout the history of post-1949 China, the family has continued to favor the education of sons over daughters, especially in rural areas where both traditional attitudes and virilocal family structure have been particularly strong." (p.360) Intensive manual labor in rural areas demands that youth support parents in their old age. In

traditional Chinese marriage, the wife moves to her husband's village after the wedding. Thus, few daughters live with or nearby their parents after marriage. In contrast, sons can bring in daughters-in-law and grandchildren to extend the family lines. This traditional gender discrimination has resulted in weak family commitment to girls' education. Moreover, given Chinese methods of agricultural production, girls are not expected to do well in mathematics and science because they are laboring in the fields. Rosen (1992) pointed out:

> In the countryside in particular, the number of girls drops sharply from lower to upper secondary school. (p.270).
> Traditional attitudes have been reinforced by economic considerations; the labor of young girls has become quite valuable. ... Adult women are mainly engaged in sideline production and are too busy to handle housework. Young girls, always partly responsible for household chores, now have virtually the entire burden thrust on their shoulders, making it difficult to fulfill school assignment. (p.272)

In urban areas, the single-child policy was implemented more thoroughly, and girls are valued higher than in rural regions. But, institutional discrimination against females also exists in urban schools. Hooper (1991) reported:

> Overt institutional discrimination occurs in the admission of females to both secondary and tertiary education. In recent years, technical schools have been particularly active in this area, imposing quotas on the proportion of girls enrolled. For example, the female quota for admission to Shanghai's technical schools in 1984 was only 28.5 per cent of the total enrollment. To attain the quotas, substantially higher entrance marks are required by girls than by boys. (p.357)

Rosen (1992) offered another example in concurrence:

> The head of one model vocational school in Beijing admitted that they "reluctantly" stopped recruiting women for Western and Chinese cooking specialties because the large hotels, the end-users of their personnel, would not take women who, among other problems, "could not carry heavy pots." (p.277)

The academic expectations are quite different for those girls who eventually are able to enter schools. Ross (1991) described:

> A female student's descriptive capabilities enhance her ability to memorize basic information, in short, to be a good student. However, being a good student becomes equated with getting good grades (to please the teacher) rather than understanding (to please themselves). Thus, a girl's capacity to think logically and abstractly remains underdeveloped. (p.83)

The underdelopment of reasoning capacity in Chinese females may be responsible, in part, in observed gender differences in student science achievement. Unfortunately, female inferiority is in line with the Confucian ethic "male honorable, female inferior" (Hooper, 1990; p.356). Moreover, "the gender variable has been largely ignored by the Chinese government" (Hooper, 1990; p.364).

In summary, according to the Chinese data analyzed in this study, gender differences in student science achievement are significant across the nation. While this empirical finding should be subjected to future reconfirmations. The consistency between this result and those reported in the previous studies should attract attention of the international community, which in turn could ultimately facilitate improvement of gender equity in the People's Republic of China.

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Table 1: Achieved Sample Sizes of the SES surveys

	Gansu	Guangxi	Hubei	InnerMongolia	Jiangshu
Sample Size	2395	2362	2961	1863	2574

Table 2: T Test -- Gender Equity of Student Science Achievement in China

Gender	Mean	Standard Deviation	T Test
Female	15.436	4.380	T(12153) = 29.364
Male	17.742	4.197	p < .0001

Table 3: Two Way ANOVA: Effects of Interaction Between Gender and Province on Student Achievement

Source	DF	Sum of Squares	F Test
Gender	1	15212.2943372	$F_{G*P}(4, 12145) = 1.77$
Province	4	632.4743355	$p_{G*P} = .1319 > .05$
Gender*Province	4	128.9349968	
Error	12145	249891.4396119	

Table 4: T Test -- Gender Equity of Student Science Achievement in Each Province

Province	T Test	
Gansu	T(2393) = 12.2321,	p < .0001
Guangxi	T(2360) = 10.6633,	p < .0001
Hubei	T(2959) = 15.7068,	p < .0001
InnerMongolia	T(1861) = 11.2795,	p < .0001
Jiangshu	T(2572) = 15.4612,	p < .0001